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REPORT AND RECOMMENDATIONS
of the
PLANT SCIENCE AND ENTOMOLOGY RESEARCH ADVISORY COMMITTEE
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PLANT SCIENCE AND ENTOMOLOGY RESEARCH ADVISORY COMMITTEE

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PREFACE

The Committee reviewed cooperative research programs of the Crops and Entomology Research Divisions of the Agricultural Research Service. It considered annual Progress Reports and other resource materials describing research activities. Research leaders briefly described the programs, discussed some accomplishments, and defined important research needs. Some Scientists at the USDA Agricultural Research Center at Beltsville, Maryland, gave several on-site demonstrations of research underway, including procedures and facilities. They also discussed achievements and problems yet to be solved.

Dr. G. L. Mehren, Assistant Secretary and Director of Science and Education, is Chairman of the Committee; Dr. H. A. Rodenhiser, Deputy Administrator for Farm Research, Agricultural Research Service, is Vice-Chairman. Dr. M. G. Weiss, Assistant to Dr. Rodenhiser, chaired the meeting.

Dr. S. G. Younkin was unable to attend the meeting.

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COMMENTS AND RECOMMENDATIONS

GENERAL

The growing complexity of agricultural research in the United States requires careful coordination and planning among private agencies, the several States, and the Federal government. Without coordination, research may be misdirected, important areas neglected, or its operation continued in traditional channels that do not meet the needs of the future. The Committee addressed itself to two aspects of the problem: the administrative techniques being used to control programing of effort and the capacity of the scientists responsible for execution of the research to adjust activities to changing conditions and demands upon research.

We were impressed by the studies that led to the compilation of "A National Program of Research for Agriculture." Representatives of the Department of Agriculture and the Association of State Universities and Land-Grant Colleges performed an invaluable service in making this study. They located present and future problem areas, set forth major objectives and proposed an action program for the next five years, and projected plans for ten years.

Long range program planning offers promise of placing responsibilities where they are most likely to be handled expeditiously. It makes possible the identification of neglected areas and adjustments before a crisis arises. The plans for future growth as set forth are realistic in that they are based upon the magnitude of the population expansion and the growing strength of the American economy. Provision is made for greater stress to be placed on the agricultural establishment as crop culture is intensified, soils abused, and production per unit area of land and manpower is increased.

In the context of its generally favorable reaction to the USDA-SAES report, the Committee emphasizes that a degree of flexibility must be built into every general long range plan to meet unpredictable contingencies and to correct errors of judgment as experience evolves.

At the operational level, the Committee found the research staff undertaking a widely diversified program ranging from direct service in problem areas to searching for new principles. The exploratory effort in searching for better ideas for solving old, recurrent problems was stimulating. Programs are being phased out reasonably promptly as problems are solved. Established programs are being modified to take advantage of new concepts. New projects have been inaugurated or are planned to attack increasingly urgent problem areas such as air pollution, pest control, and reduction of hazards from pesticide use.

The skillful placement of funds to support extramural research and solicit cooperation of other institutions has been a constructive move. We

urge continuation and expansion of this activity because it is appropriate that the Department should play a leading role in coordinating the research program in agriculture and basic biology related to agriculture.

We note the serious difficulty being encountered in finding highly qualified scientists for staffing. At the present time, there are not enough agricultural scientists being trained to meet national and world needs. The projection of the needs for scientists in the years ahead points out the necessity for encouraging students to enter agricultural research. It is, therefore, important that greater emphasis be placed on the encouragement of graduate training in the awarding of extramural grants and contracts for research at universities. To further accomplish this objective, we recommend that the Department seek authority and funds for the establishment of graduate and post-doctoral fellowships in agriculture.

A major problem area is developing which requires careful study. A nationwide scarcity of the personnel skilled in taxonomic biology has influenced the quality and depth of the research effort in this area. This is most unfortunate because the proper identification of the living subject and knowledge of its relation to other forms of life is indispensable to sound biological research. There is a great need for a center where aggressive research in systematics will be assured to take advantage of the changing concepts in molecular biology, evolutionary biology, genetics, ecology and biochemistry.

It is recommended that funds be made available for creating a national facility for systematic biology with strong staffs of systematic botanists, entomologists, mycologists, bacteriologists, protozoologists (including nematologists) and possibly virologists. It should include adequate facilities for studies of living organisms, emphasizing developmental biology. Location in the general vicinity of the new Agricultural Library and the National Arboretum would be decidedly advantageous, and the Smithsonian Institution should be invited to participate with the Department of Agriculture.

The problem of making studies on harmful insects, mites, plant pathogens (fungi, bacteria, nematodes and viruses), without unnecessarily jeopardizing crops, is very real. For example, a new virus of corn was discovered in the Midwest four years ago, but comparative tests with certain foreign diseases of similar outward appearance have not been made because new diseases should not be introduced willfully into either this or other countries. Yet, it is essential to know whether they are identical. An alternative to studies in this country would be to establish a laboratory in an isolated area, e.g., an island, for experimentation where agriculture would not be jeopardized. Knowledge on epidemiology and ecology of pests could be obtained before they reach the United States. The Committee urges that funds be made available for a feasibility study for establishing such a laboratory.

The significance of "remote sensing" techniques to agriculture in determining disease and insect outbreaks, in classifying soils, in determining plant and soil moisture stresses, etc., is still not adequately appreciated among basic and applied biologists. It is recommended that the Department organize a symposium in which scientists may be informed as to present developments and future potentials. Early consideration should be given to this recommendation. The Agricultural Research Institute of the National Academy of Sciences--National Research Council might sponsor such a symposium.

The Committee takes note of the apparent need for germ plasm centers or repositories for those basic crop plants and beneficial insects not served by present facilities. A comprehensive survey of these needs should be made, and centers established and maintained where they are needed. Germ plasm centers should include such important agricultural assets as bee breeding stocks and tree fruits and nuts, as well as other asexually propagated plants. These would complement the National Seed Storage facility. The possibilities of using tissue cultures as germ plasm banks should be investigated more fully.

BASIC BIOLOGY OF CROP PLANTS

The Panel on the Plant Sciences of the Committee on Science and Public Policy, National Academy of Sciences--National Research Council, recently proposed ". . . . that the U.S. Department of Agriculture, the National Science Foundation, or some other appropriate agency, be allotted a research fund to be specifically devoted to studies of the basic biology of the world's principal food plants." The crop plants included in the suggested program are: corn and sorghum; wheat, rye, oats and barley; sugarcane; beans, soybeans, and peanuts; sugar beet; potato; sweetpotato and cassava; banana and coconut. The Department of Agriculture should consider making an inventory of its present involvement in research on these crops. It is the appropriate agency to administer the proposed program and to coordinate such research activities with the State Agricultural Experiment Stations and other agricultural research institutions.

PHOTOSYNTHESIS OF CROP PLANTS

Recent studies on the comparative physiology of the photosynthetic mechanisms in crop plants have revealed significant differences in metabolic pathways. These studies should be expanded to include the major crop plants with the objective of identifying the factors that limit photosynthetic efficiency.

Studies should also be carried out on the effects of nutrition, moisture stress, carbon dioxide concentration, air pollutants, cultural practices (density of planting, cultivation, etc.) and pesticides on the photosynthesis of crop surfaces. Previous studies have generally been carried out on isolated leaves or on unicellular plants. Research is needed on intact plants and plant communities.

PLANT INTRODUCTION AND EVALUATION

The collection, increase, evaluation, and distribution of plant germ plasm continue to be of prime importance to agriculture. Many significant contributions have been made through the use of this germ plasm. However, gaps still exist that restrict full exploitation of its potential.

An additional program is urgently needed to prevent the loss of clones of fruit and nut varieties which are essential to preserving a broad gene base. The surveys conducted by the Department at the request of the National Coordinating Committee on New Crops have clearly shown that Federal and State collections of fruit clones are decreasing and will continue to decrease. It is recommended that a system of clonal repositories of fruit and nut varieties be developed to preserve the breadth of germ plasm considered desirable. The decisions concerning the repositories needed, the collections to be included, and the method of maintenance and distribution of stocks should be made by select committees of scientists from the USDA and State Agricultural Experiment Stations.

The facilities at the Regional Plant Introduction Stations are not adequate to multiply seed stocks of new introductions that must be subjected to inspection for freedom from seed-borne diseases. Beans, in particular, have recently been restricted in primary increase at Regional Stations in Washington and New York at a time when breeders require new disease resistant germ plasm. It is recommended that facilities for isolation and primary increase of such seed stocks be developed and, insofar as is practical, that these be within the present operating responsibilities of the Regional Plant Introduction Stations. This will insure the continuity of evaluation and increase that is so effective in the present system.

The addition of an entomologist to each Regional Plant Introduction Station should have a high priority in staffing. Insect resistance in crops can reduce the need for insecticides. The potential that exists for identifying insect resistant germ plasm as a part of the evaluation process is not being adequately exploited. The use of resistance to plant diseases and insects identified by a pathologist and entomologist team at the time of primary evaluation can be of great value in reducing the incidence of insect-borne diseases as well as reducing damage to crops by feeding and parasitic micro-organisms.

The Department is commended for its effort in identifying potential new crops and defining the specific uses that can be made of them. In particular, the close working relationships of research units of the Department in such developments is outstanding. There is a continued need for this research to identify new natural sources of fibers, chemicals, proteins, gums, oils, and medicines.

PLANT BREEDING AND GENETICS

The Committee is pleased to note the gradual shift in emphasis from applied breeding programs to basic breeding and genetics research with corn, sorghum, alfalfa, and other crops on which private industry has developed substantial applied breeding programs. To assure maximum efficiency and productivity of the combined efforts of public and private plant breeders, the development and prompt release of basic genetic information, improved breeding systems, germ plasm pools possessing a number of desirable traits, and other valuable breeding stocks, is recommended.

Increased attention should be directed toward a better understanding of gene action as well as the interaction of genes and the cytoplasm. The chemical basis of gene action, including genetic codes, and the physiologic processes controlled by genes require research emphasis to better understand and exploit heterosis via various sterility systems.

Research should be continued and expanded to develop disease and insect resistant plants. This approach to pest control not only enhances the effectiveness of chemical control measures, but also helps to minimize pollution of the environment.

Research should be initiated to assess the extent of damage to all of our major crops caused by atmospheric pollution and to determine and identify sources of plant resistance to pollutants that cause economic damage.

The effects of the $opaque_2$ and $floury_2$ genes in corn are examples of significant changes in the nutritional quality of plant products through breeding. This can have favorable far-reaching consequences in supplying both the quantity and quality of food required for the increasing world population. With the advent of improved analytical methods, consideration should be given to a survey of breeding material of other food and feed plants, including plant introductions, for sources of genes that may produce equally significant results in other high yielding crops.

Breeding work to modify crop plants for mechanical production, harvesting, and field processing should be undertaken and expanded wherever feasible to reduce labor requirements and improve production efficiency.

The Committee was disappointed to note that no action has been taken to implement the recommended expansion of research on the perennial grasses, legumes, and turf. We recommend that these items be given a high priority in future program planning and budgeting.

CROP QUALITY

The importance of proteins in meeting world food requirements places great emphasis on the need for information on the types and quantity of proteins in major food and feed crops. It is recommended that research be accelerated

on methods of protein analysis and determination of high protein germ plasm in major food and feed crops. Techniques should be found that will enable rapid and early selection of high protein mutants or breeding progeny. A close liaison must be maintained between research on quality and programs with breeding and cultural objectives.

Continued emphasis is needed on biochemical research on quality attributes. More precise definitiion must be made on components of color, flavor, and texture and how these may be modified. The rapid changes in crop technology, such as mechanical harvesting, require a continual assessment of the adequacy of crop grade standards. Such quality definition must both protect the consumer interest and be fair to the producers and processors of agricultural commodities.

PLANT CULTURE AND MANAGEMENT

Present interest in beautification of our environment and improvement of rural communities emphasizes the need for more research on trees, shrubs and other ornamentals, and on turf. Knowledge relative to cultural practices and management of many of our standard and recently introduced ornamental species is lacking. Such factors as the environmental stresses that are placed on exotic species, ornamental or otherwise, when transplanted to our environment, are poorly understood. Because of these shortcomings, the Committee recommends that more support be given to research on ornamentals that could be grown in different parts of the country.

The Committee recommends that research be continued at the present level on the cultural requirements of crop plants to make them more adapted to mechanical handling.

To assure maximum yield from new genotypes, cultural and management practices need to be reexamined in the light of necessary changes in field environments, cropping systems, and the use of fertilizers and pesticides. Such physio-ecologic research should be continued and expanded.

AIR POLLUTION AND PLANT GROWTH

The Committee notes the formation of an Air Pollution Laboratory at the National Agricultural Research Center. Efforts should be made to expand this work and to encourage close cooperation with other agencies now engaged in air pollution studies.

The effects of chronic or long-term exposure to low levels of pollutants on crop productivity should be examined. Ways in which these chronic effects may influence the response of the plant to fertilization, moisture stress, pesticides, and other environmental factors should be determined.

The remote sensing techniques being developed should be integrated into pollution studies. It may be possible to use such techniques to detect "hidden damage" and other pollution effects on plant growth. Such techniques may also make it possible to carry out an aerial survey of the major crop-producing areas to determine the extent of pollution damage.

Most plants give off volatile compounds into the atmosphere. Some research should be initiated to identify these "volatiles" and to determine whether they interact with, or modify the action of air pollutants.

Attention should be given to surveying the extent to which different plants accumulate and concentrate common air pollutants.

PESTICIDES AND GROWTH REGULATORS

The Department is commended for the excellent progress being made in the development of biological methods of insect control and recommends that this work be continued. It is also noted that chemical pesticides are the major means of controlling insect pests of crops, livestock, and man. Therefore, additional research is required to provide chemicals for continuing safe, effective, and economical insect control.

We recommend that more work be done combining biological and chemical control methods. To accomplish this, work is urgently needed on the relative toxicity of insecticides to both pests and their parasites and predators. This information would make it possible to minimize the damage to beneficial insects and thus reduce the amount of pesticides required for control. Detailed studies of the biology of both pest insects and beneficial insects are also essential. If the biology and population dynamics of pest and beneficial insects were thoroughly understood, it would be possible to use pesticides only when necessary and then in the minimum amounts required.

In the opinion of this Committee, the USDA can be of great service by gathering the basic scientific information which is essential for the development of safer, more sophisticated methods of pest control by either chemical or biological means. In several areas the Department is already doing this. The Metabolism and Radiation Research Laboratory at Fargo, North Dakota, the pioneering entomology research laboratories at Beltsville, Maryland, and the herbicide-chemistry laboratory at Beltsville have already made very significant contributions. Support of these groups should be continued and extended. There are several other areas in which new programs of this type must be initiated if significant progress is to be made.

The type of work being done on photosynthesis of crop plants, fat metabolism in corn, and protein biochemistry of corn needs to be continued and expanded to include other plant biochemical systems. The elucidation of the biochemical factors involved in the host plant-disease complex would be invaluable in designing both chemical and biological control methods for plant diseases.

Work on the biochemical mechanism of action of fungicides and nematocides is urgently needed for the development of more effective new materials to control these pests. Studies of the factors related to such things as drought resistance, frost injury, seed germination, and plant maturation could lead to new chemicals to control plant development which would greatly increase crop production and decrease losses due to adverse weather conditions.

Careful and detailed study is required of the factors which limit plant yields. More studies of the levels of insect pest populations which are actually limiting yields of crops, such as forage legumes, should be made. In addition, it may well be that there are significant but unrecognized factors such as nematodes and soil pathogens which limit crop yields in many areas. Adequate description of these factors could lead to more effective application of chemical pesticides in areas where more material than is actually required is now used, and to the development of new materials for problems which are not now fully appreciated.

Great concern has been expressed over the contamination of both soils and water with persistent chemical pesticides. A number of Federal agencies are conducting monitoring studies to determine the extent of this contamination. In many cases, preliminary results have shown the actual amounts of contaminants resulting from agricultural use of pesticides to be small. Additional work is needed to determine any effects of these residues on soil, crops, animals, and man.

The amounts of pesticide absorbed from contaminated soil by some crops has been determined. This work should be expanded so that, by knowing the amount of residue in the soil, it will be possible to predict whether or not crops grown on it will be likely to contain illegal residues. In this connection, methods for the decontamination of soil should be developed. In studies on the problem of residues in the environment, it is strongly urged that the government agencies involved be encouraged to study not only the amount of pesticide residues present, but whether they pose a significant physiological hazard to either man or animals.

The control of pests by soil application of pesticides has become increasingly popular in recent years. Information is urgently needed on the effects of the more commonly soil-applied pesticides on the chemical, physical, and biological properties of soil. These effects should also be studied with the more commonly used combinations of herbicides, insecticides, and nematocides. The effects of pesticides on uptake of nutrients, on plant growth, and on plant composition should also be investigated.

Research on residue analytical methods applicable to groups of insecticides is underway in the Entomology Research Division laboratories at Beltsville, and very commendable contributions have been made. This work should be continued. A similar facility is recommended for the Crops Research Division for the study of residues of herbicides, fungicides, nematocides, and growth regulants. This facility would provide for development of general survey methods for the additional types of pesticides listed and would also provide an urgently needed service to other sections of the Crops Research Division.

The Committee is pleased to note significant advances in methods of application of pesticides to crops. Continuation and extension of these studies, as well as modification of formulations, should lead to increased efficiency and decreases in environmental contamination. Some factors needing investigation are the type and location of deposits which give most effective control of different types of pests, the effects of different solvents and adjuvants on absorption by foliage and the nature of pesticide deposits, the effect of particle size on biological efficacy, and methods for control of particle size in sprays. Such studies will require the coordinated efforts of chemists, biologists, and agricultural engineers.

The introduction of the ultra low volume technique for application of pesticides has resulted in serious concern regarding drift problems. Two important considerations are contamination of adjacent crops and possible human exposure. In order to evaluate the drift problem, basic data should be developed under controlled conditions. Some of the factors that require evaluation are: wind velocity, particle size of sprays, type of spray (low volume or conventional), spraying height, inversion, and types of spray equipment. The Department has already initiated studies on this important problem. These should be extended.

The Committee would also like to reaffirm the recommendations made in 1966.

BIOLOGICAL AND CULTURAL CONTROL OF PLANT DISEASES

The incorporation of genetic resistance to diseases in crop plants is the ultimate in control systems. Since biologic materials are in a constant condition of transition, however, it is impractical to assume that inherent reistance alone can ever provide total plant disease control. Chemical controls also have economic and safety limitations.

The practical importance of cultural controls demands constant and continuing attention. It is again recommended that greater emphasis be given to new and improved cultural practices for the limiting of diseases of crop plants.

The Committee wishes to draw particular attention to the inadequacy of research pertaining to bacterial diseases of crop plants. These are widespread among crop species and particularly among the pulses. It is recommended that the programs of research with bacterial diseases be greatly expanded in such areas as the identification and classification of bacterial pathogens; the transmission and survival of the organisms on seeds, other host parts, and in soils and water; and on the development of cultural, biological, genetic, and chemical controls.

The total complex and economic importance of diseases attacking crop plants demands increased attention to basic research on the biology of causal organisms; host-parasite relations; and biochemical, genetical, physiological and other bases for resistance or susceptibility.

BIOLOGICAL AND CULTURAL CONTROL OF WEEDS

The control of weeds by nonchemical procedures offers many possibilities in an integrated weed control program. Information is needed on the life histories of weed species and predators of such species. Such studies should be carried out in controlled-environment facilities, and should be accompanied by comparable studies on appropriate crop plants. Attention should also be given to the environmental requirements of the plants at different stages of growth and development.

The facilities at Beltsville, Maryland, for studying the effects of radiant energy on plant growth and development would be useful in studies of the life histories of weeds. There is ample evidence that the phytochrome pigment system regulates many aspects of plant growth, including seed germination, tuberization, flowering dormancy, protein synthesis, etc. A study of the phytochrome system in weed species at different stages of development should be initiated.

The studies that led to the identification of a germination stimulant for witchweed are indicative of an approach to biological control that should be expanded to other weed species.

BIOLOGICAL AND CULTURAL CONTROL OF NEMATODES

Nematodes and the extent of their occurrence throughout the United States and the world continue to be unknown quantities. Accumulating evidence suggests that insidious losses from nematodes parasitic to certain species of crop plants are more extensive than previously estimated. Control systems must be explored based on a fundamental understanding of the physical, chemical, and biological properties of nematodes within their environment.

It is recommended that the necessary steps be taken to (1) expand investigations to determine the distribution and identification of plant parasitic nematodes in the United States and to develop a better estimate of losses caused to crop plants; (2) initiate research on ecological relationships of nematodes with other organisms, including disease-producing pathogens; (3) expand research on biologic control of nematodes by parasitic fungi, flatworms, and other organisms; and (4) initiate research on the basis for differential attraction of nematodes to specific host plants, including the biochemistry of the sensory mechanism of the nematode and the biochemical reactions between nematodes and host plants.

BASIC INSECT BIOLOGY, PHYSIOLOGY, AND PATHOLOGY

We note that research is being continued on insect viruses, tissue culture, and the development of methods for mass rearing certain insect species; also, that extramural grants and contracts for work on insect viruses have been initiated.

Research in recent years on insect hormones has made these materials appear quite promising as agents for suppressing or controlling insect populations. It is recommended that this effort be increased and directed towards further basic research on insect steroids and hormones, and on exploring the potential usefulness of these substances in insect control. It is suggested that the basic research program should include work on the chemistry of both naturally-occurring and synthetic hormones and studies on their biochemistry and modes of action. The use of these materials in insect control should be explored individually and in integrated programs.

The capability for successfully rearing major pest species on a synthetic diet is of great importance. In addition to evaluating the gross effects of nutrients on insect growth and metamorphosis, thorough studies should be made of some of the more subtle effects of nutritional deficiences on insect behavior and biology--e.g., vision, response to light, etc. Therefore, it is recommended that increased effort be devoted to both basic nutritional research and its application in the development of mass rearing methods.

Promising results are being obtained on the effectiveness of insect viruses for insect control in the field, their safety to animals other than insects, and their ease of production. Because these viruses have great potential in insect control, it is recommended that basic research in the area of insect pathology be expanded with emphasis as follows: (a) further develop techniques for tissue culture of insect viruses and other pathogens (b) develop methods for standardizing microbial agents, (c) select more virulent strains of known insect viruses, and elucidate their modes of action, and (d) find means of formulating viruses to ensure pathogen activity in field applications. It is suggested that special emphasis be given to insect tissue culture, as significant findings in this area may have applications in medical and/or plant virology as well as in insect virology.

INSECT IDENTIFICATION AND CLASSIFICATION

The Committee was disappointed to learn that, due to the scarcity of trained personnel, it has not yet been possible to add measurably to the scientific staff in insect taxonomic units. We recognize that expanding the staff is essential, not only to meet ever increasing demands for research and identifications resulting from continually expanding research in the biological sciences, but to provide replacements for vacant positions.

We recommend that every reasonable encouragement be given to appropriate educational institutions for the training of taxonomists. It is further recommended that, whenever appropriate, research contracts and grants be initiated that encourage the training of future researchers in this discipline. Particular attention should be directed to the development of specialists in aphids, termites, and the beetle families Staphylinidae and Carabidae.

It is recommended that efforts be continued to place one subprofessional assistant with each senior taxonomist, so that these key scientists may be relieved of their current heavy burden of preparatory work and routine identification.

The Committee is gratified to learn of the progress made by represenatives of the Department and the Museum of Natural History of the Smithsonian Institution in planning a joint facility at the Agricultural Research Center for research in biological systematics, as included in the General Recommendation section of this report. It is understood that a final decision concerning participation by the Smithsonian Institution in this joint venture has not yet been made.

It is recommended that representatives of the Department of Agriculture continue to work with the Smithsonian Institution toward the goal of establishing a joint facility at the National Agricultural Research Center as was proposed last year.

It is obvious that there exists a continually growing need for initiating and conducting biosystematic research of an entomologic nature within the Department that will provide experimental evidence to supplement that obtained by traditional anatomical studies in insect classification and identification. In the event the Smithsonian's decision favors a location for its Department of Entomology that will not allow expansion for the combined staffs in biosystemics, this Committee recommends that plans be formulated for an adequate facility at the National Agricultural Research Center for this research.

BIOLOGICAL AND SPECIFIC CHEMICAL METHODS OF INSECT CONTROL

The Committee recommends acceleration of foreign exploration for beneficial insects. In order to meet the developing needs of a rapidly increasing domestic research program on the use of biological methods for control of insect and mite pests, it is essential that the search for parasites, predators, and pathogens suitable for introduction into the United States be accelerated. This work should be directed toward finding superior germ plasm that shows useful characteristics, either for direct control or for control through mass propagation and periodic release.

In order to accommodate increased activity on exploration for beneficial insects and pathogens and to provide better coverage of agricultural regions comparable to those of the United States, an additional foreign parasite laboratory should be established. This center for exploration and associated research should be located near the center of the Eurasian land mass, possibly in Ankara, Turkey.

The Committee urges an expansion of the limited research on total insect population control which has been initiated on St. Croix in the Virgin Islands. The present facilities are shared with other Federal agencies and are inadequate for even the current limited research program. Adequate Federally-owned

land is available. There is an urgent need in this location for facilities and a staff of entomologists, chemists, and agricultural engineers to develop research on control of total populations of such insects as tobacco hornworm, tobacco budworm, cotton bollworm, pink bollworm, sugarcane borer, horn fly, stable fly, and other species based on application of one or several integrated techniques as conditions permit. Research of a similar nature should be implemented at other appropriate locations.

Research on male annihilation techniques should be intensified. The technique of combining a toxicant with a strong chemical attractant for males of the Oriental fruit fly was successful in eradicating that insect from the island of Rota. The finding of strong responses by males to the sex pheromones produced by virgin female peach tree borers, lesser peach tree borers, tobacco hornworms, pink bollworms, cabbage looper, and other insects and the identification and synthesis of several such pheromones offers a promise of utilizing these in luring and destroying the male populations, and thus eradicating or controlling pest species over large areas.

Research on chemical and physical factors affecting host selections should be expanded. There is a continuing need for intensive research on the factors that cause insects to seek out, feed or oviposit on certain plants and to avoid others. This problem is central to selecting candidate insects for weed control and to developing attractants for insect survey and control, repellents for crop protection, and insect-resistant strains of plants.

INSECT VECTORS OF PLANT AND ANIMAL DISEASES

It is recommended that increased attention be given to the role of arthropods in the transmission of animal diseases. This will mean accentuation of the present studies on transmission of livestock diseases--such as bovine anaplasmosis, equine piroplasmosis, and bluetongue--and the initiation of research on transmission of such important poultry diseases as fowlpox, avian leukosis, and leucocytozoonosis. Studies are needed on arthropod vectors, reservoirs and life cycles of disease agents, modes of transmission, the biology and behavior of the vectors, and methods of control.

Attention is again directed to the importance of sugar beet, corn stunt, maize dwarf mosaic, and peanut stunt viruses. It is recommended that research efforts on these be continued or expanded in order to satisfy the urgent need for fundamental studies on vector-virus relationships and the over-wintering hosts serving as reservoirs for the causative agents. The importance of an isolation laboratory for studies of this kind should be reemphasized. It would make possible the study of potential plant pests not present in the United States. It would also permit investigation of certain native disease-vector relationships under more favorable conditions.

BEES AND OTHER POLLINATING INSECTS

The Committee was pleased to note that the Bee Laboratory at Tucson has been constructed and partially staffed. Immediate and complete staffing of this important laboratory is vital to the bee industry and to many segments of agriculture. It is strongly recommended that sufficient funds be allocated to provide complete staffing with both scientists and supporting personnel.

Recent discoveries have indicated that the trait in honeybees to collect specific pollen is heritable. This opens a new field of development for apicultural geneticists. Such inherited traits offer the potential for developing pollinators specific for a given crop. It is recommended, therefore, that funds be provided to study and select honeybees and other pollinating insects with genetic response for specific activities.

Sufficient funds should be made available to construct the bee stock center that has been planned. This becomes more essential than ever now that genetics research will be conducted on selective pollinator strains.